



## MEMORANDUM

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*DATE:* December 1, 2010  
*TO:* Dan Graham, PacRim Coal, LP  
*FROM:* Jerry Diamond and Henry Latimer  
*SUBJECT:* Use of site-specific total:dissolved metals ratios to determine appropriate metal concentrations for use in confirmatory WER testing

Based upon discussions between PacRim Coal, LP, Alaska Department of Environmental Conservation (ADEC), EPA, and Tetra Tech, it has been determined that prior to adoption of site-specific criteria based on the water-effect ratio (WER) submitted by PacRim (March 2010) confirmatory testing is necessary. This memo outlines the concentrations of aluminum, copper, lead, and zinc to be used in this confirmatory test as well as the methodology used to determine these concentrations.

As discussed previously (e.g., memo of November 2, 2010), the metals (aluminum, copper, lead, and zinc) will be spiked to meet total recoverable concentration goals. Because of the complex nature of the resulting mixture of aluminum, copper, lead, and zinc in an ambient water sample, it is impossible to predict the dissolution of these various compounds. While each metal will be introduced as a soluble salt that will readily dissolve in water, the resulting dissolved metal concentrations in the mixture may or may not be as predicted based on single metal tests due to the formation of various hydroxides or more complex chemical forms in this solution. In fact, it is impossible to control the dissolved fraction of copper, lead, and zinc in the resulting solution without significantly altering the chemistry of the ambient sample (e.g., significant pH manipulation), which is both unrealistic and not in keeping with the site water characteristics. Therefore, we will use a concentration goal based on the total recoverable fraction of each metal. These total recoverable metal concentrations are determined using site-specific total:dissolved ratios for each metal (copper, lead, and zinc) determined at similar concentrations in the recently completed WER study (Table 1). Keep in mind that no acute site-specific aluminum criterion has been proposed and therefore, aluminum will be added to meet a concentration goal of 750

µg/L (Alaska State acute water quality standard). Thus, spiking with copper, lead, and zinc salts to meet the total metals goals should ensure that sufficient metal is present in the solution to allow concentrations of dissolved fractions of each metal to reach site-specific criteria levels, if chemically possible.

Table 1. Summary of site-specific acute criteria (µg/L) as dissolved for each metal as well as total:dissolved metal ratio at similar concentrations from WER study and the resulting total metal concentration in sample needed to achieve dissolved metal goals assuming total:dissolved metal ratios remain the same as in single-metal tests.

Metal	Hardness (mg/L)	Site-specific acute criteria (dissolved as µg/L)	Measured total:dissolved ratios from WER	Mean total:dissolved ratio from WER	Total metal to achieve desired dissolved metal value (µg/L)
Cu	25	24.39	0.74 - 0.88	0.81	30.20
Pb	25	123.27	0.39 - 0.67	0.49	251.58
Zn	25	42.36	0.74 - 0.81	0.77	55.01

The approach above is expected to determine the mixture effect of the proposed dissolved criteria levels. Furthermore, the proposed approach should provide a realistic test of effects of the mixture of these metals in the stream. Depending on how the internal reactions of the spiked metals affect the final dissolved metal levels (which are beyond laboratory controls), the final site-specific criteria would remain as dissolved (incorporating the WERs based on dissolved metal in single metal tests) or could revert to the tested total levels (incorporating WERs based on total metal in single metal tests), depending on: (1) the observed differences between dissolved metal levels in the mixture as compared to single metal tests, and (2) assuming the test passes without a demonstration of toxic effects. We believe that the methodology and understanding described here is in keeping with the application of these criteria into the site-specific standards, the 1994 WER guidance, and EPA's goals as stated in ongoing discussions.